Claims

What is claimed is:.

1. A method for rapidly controlling the rate of ion generation in an ion source having a filament-cathode and a mirror electrode, the ion source being operable to generate an ion beam from the ionization of ion precursor gas present in the chamber by electrons emitted from the filament, the method comprising the steps of:

supplying current to said filament-cathode;

supplying current to said mirror electrode; and

controlling the potential difference between said filament-cathode and said mirror electrode by modifying the potential of the mirror electrode to control the number of electrons available for ionization.

2. The method of claim 1 further comprising the step of reducing the ion beam intensity by driving the potential of the mirror electrode positive relative to the filament cathode.

3. The method of claim 1 further comprising the step of increasing the ion beam intensity by driving the potential of the mirror electrode to negatively bias the mirror electrode relative to the filament of the ion chamber.

4. The method of claim 1 wherein the filament cathode is a directly heated cathode.

5. The method of claim 1 wherein the filament cathode is an indirectly heated cathode.

6. The method of claim 1 further comprising the step of modulating the number of electrons in a manner that varies the ion beam from a first intensity to a second intensity during a time frame of less than one millisecond.

7. A method for rapidly controlling the rate of ion generation in an ion source having a filament-cathode, a mirror electrode, and at least one grid, the ion source being operable to generate an ion beam from the ionization of ion precursor gas present in the chamber by electrons emitted from the filament, the method comprising the steps of:

supplying current to said filament-cathode;

supplying current to said mirror electrode;

supplying current to the grid, and

controlling the potential difference between said filament-cathode and said grid by modifying the potential of the grid relative to the filament to control the number of electrons available for ionization between the grid and the mirror electrode.

8. The method of claim 7 further comprising the step of reducing the ion beam intensity by driving the potential of the grid positive relative to the filament cathode.

9. The method of claim 7 further comprising the step of increasing the ion beam intensity by driving the potential of the grid to negatively bias the grid relative to the filament cathode.

10. The method of claim 7 wherein the filament cathode is a directly heated cathode.

11. The method of claim 7 wherein the filament cathode is an indirectly heated cathode.

12. The method of claim 7 further comprising the step of modulating the number of electrons in a manner that varies the ion beam from a first intensity to a second intensity during a time frame of less than one millisecond.

13. An improved ion source apparatus for rapidly modulating the intensity of an ion beam, comprising:

an ion chamber having mutually opposed sides and configured to receive ion precursor gas;

a filament-cathode located on one side of said ion chamber and operable to emit electrons for the ionization of the precursor gas for the generation of the ion beam; and

a mirror electrode having a potential associated therewith and located on the other side of said ion chamber, said mirror electrode being connected to a circuit to vary its potential relative to said filament so as to vary the number of the electrons available in the ion chamber for ionization.

14. The apparatus of claim 13 wherein said mirror electrode is operable for modulating the ion beam between a first and second intensity during a time frame of less than 1 millisecond.

15. The apparatus of claim 13 wherein the filament cathode is a directly heated cathode.

16. The apparatus of claim 13 wherein the filament cathode is an indirectly heated cathode.

17. An improved ion source apparatus for rapidly modulating the intensity of an ion beam, comprising:

an ion chamber having mutually opposed sides and configured to receive ion precursor gas;

a filament-cathode located on one side of said ion chamber and operable to emit electrons for the ionization of the precursor gas for the generation of the ion beam;

a mirror electrode located on the other side of said ion chamber, and

at least one grid extending inside said ion chamber and positioned between said filament-cathode and said mirror electrode, said at least one grid being connected to a circuit to vary its potential relative to said filament and being operable so as to vary the number of electrons available in the ion chamber for ionization.

18. The apparatus of claim 17 wherein the filament cathode is a directly heated cathode.

19. The apparatus of claim 17 wherein the filament cathode is an indirectly heated cathode.

20. The apparatus of claim 17 wherein said grid is positioned in proximity to said filament-cathode so as to vary the number of electrons available for ionization between said at least one grid and said mirror electrode.